A Parametric study of an Ankle-Foot Orthosis

í Skorini, Ragnhild; Mikkelsen, Lars Pilgaard; Løgstrup Andersen, Tom; Falkenman, Lars

Publication date:
2010

Risø DTU
National Laboratory for Sustainable Energy

A Parametric study of an Ankle-Foot Orthosis

R. í Skorini, L.P. Mikkelsen, T.L. Andersen, Materials Research Division, Risø DTU, Roskilde
Lars Falkenman, Ortopæd Ingeniørerne, Roskilde

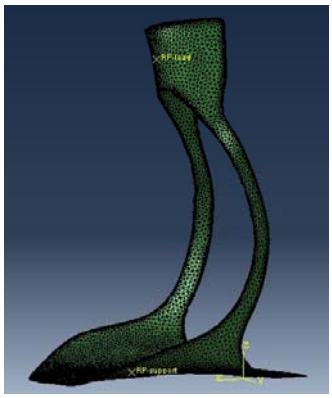
Drop foot can be defined as an impairment or lack of function ankle and toe dorsiflexors. One treatment for drop foot is to wear an Ankle-Foot Orthosis (AFO). The aim of this study is optimize the material selection for an AFO. A person specific AFO was made. Based on 3D-scan of the AFO, a full 3-D finite element model of the AFO was built up in the commercial finite element code Abaqus. A prescibed displacement was applied to the upper part of the AFO to simulate normal gait. Failure strain criteria were defined for the rod reinforcement material. The reinforcement material was directed along the rods of the AFO. Based on the simulations, regions with predicted material failure can be identified.

Model development

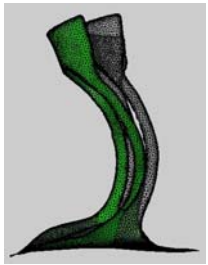
AFO production

Person wearing AFO

AFO prepared for 3D scan



STL representation of whole model

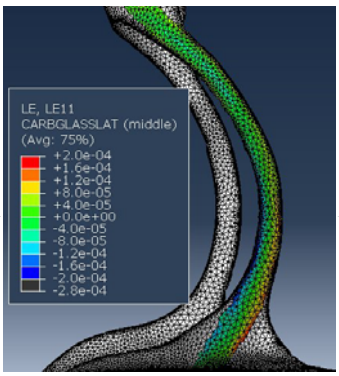


Prescribed displacement

Results

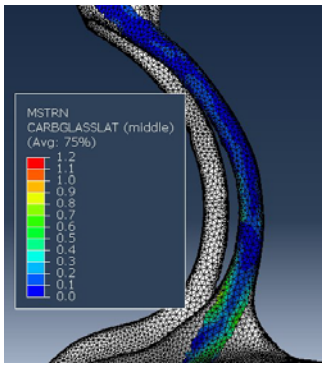
Failure criteria:

$$L_F = max\left(\frac{\varepsilon_{11}}{X_\varepsilon}, \frac{\varepsilon_{22}}{X_\varepsilon}, \left|\frac{\gamma_{12}}{S_\varepsilon}\right|\right) < 1.0$$

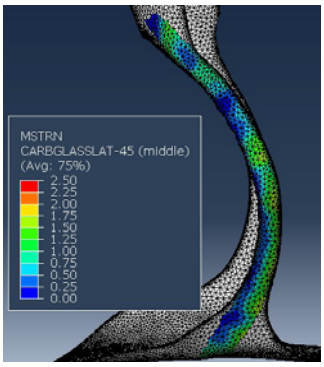


S_{11} for carbon UD reinforcement

MSTRN values > 1 predict material failure



MSTRN values for carbon UD reinforcement



MSTRN values for rotated carbon reinforcement

Conclusion

The finite element method is found to be a strong tool improving the material selection process used in a biomechanical device. Based on simulations, a large number of expensive trial and error iterations can be avoided.